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FASTENER DRIVING APPARATUS

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This invention relates to a fastener driving apparatus, and, more particularly, to a fastener driving apparatus including new and improved means for arresting movement of a piston.

Fastener driving tools of the type in which a fastener driving element is moved through a single power stroke by a fluid or pneumatically actuated drive piston commonly include bumper means for cushioning the termination of the power stroke of the drive piston. These bumpers or bumper assemblies generally have been formed of resilient members, such as one or more bodies of natural or synthetic rubber, disposed in the path of movement of the drive piston adjacent the lower end of the cylinder. Although these assemblies function properly throughout an operating life commensurate with the expected useful life of the types of tools now in use, the design of tools for driving larger fasteners, such as common nails, has made it necessary to obtain greater energy from the drive piston during the single power stroke. This means that greater forces must be damped or absorbed from the drive piston at the termination of the power stroke, and there are indications that the rubber or resilient body type of bumper will not be able to withstand these increased forces over extended periods of time.

Accordingly, one object of the present invention is to provide a new and improved fastener driving apparatus.

Another object is to provide a fastener driving apparatus including a new and improved bumper assembly.

Another object is to provide a fastener driving tool including new and improved means for cushioning the termination of the power stroke of the drive piston in the tool.

Another object is to provide a cushioned piston stop in a fastener driving tool in which the movement of the drive piston is cushioned and retarded by engagement with a piston means biased by a pressurized fluid.

A further object is to provide a cushioned piston stop including a cylinder containing a slidably mounted piston means which is pneumatically biased toward a position to be engaged by a drive piston at the end of the power stroke of the drive piston.

Another object is to provide a bumper assembly for cushioning the termination of the power stroke of a drive piston in which the drive piston strikes a resilient body carried on a pneumatically biased piston to permit part of the energy of impact to be absorbed by the resilient body and the remaining part by movement of the piston means against its bias.

In accordance with these and many other objects, an embodiment of the present invention includes a pneumatically actuated fastener driving tool comprising a housing defining a cylinder having an open end to which pressurized fluid or compressed air is selectively supplied to actuate a fastener driving means. The fastener driving means comprises a piston slidably mounted within the cylinder and having a dependent driver element or blade that passes through the lower end of the cylinder to be slidably received within a drive track to which successive fasteners, such as staples or nails, are supplied by a suitable magazine assembly. To provide means for cushioning the termination of the power stroke of the piston, a new and improved bumper or cushioned piston stop assembly is disposed in the lower end of the cylinder.

This assembly comprises a cylinder of two different diameters concentric with the drive cylinder which contains a slidably mounted piston of two corresponding diameters. Pressurized fluid is supplied to the cylinder between the different diameter portions thereof to pneumatically bias the piston means toward the drive piston and into a position determined by engagement with stop means carried on the housing of the tool. This piston means in the bumper assembly carries a body of resilient material whose upper surface extends upwardly beyond the upper surface of the piston means and which includes a centrally disposed aperture through which the driver blade extends to be received within the drive track.

When the tool is operated, the drive piston moves downwardly to actuate the driver blade, and the lower end of the piston strikes the resilient body carried on the piston means at the end of the power stroke. The drive piston and the piston means move downwardly together against the pneumatic bias provided by the pressurized fluid until the piston means strikes a resilient stop limiting its downward movement. The remaining energy of the drive piston is absorbed by distortion of the resilient body carried on the piston means. When the drive piston is returned to its normal position, the resilient body is restored to its normal position and the pressurized fluid supplied to the cylinder means in the bumper assembly restores the piston means therein to its normal position. Thus, the bumper assembly utilizes both movement of the piston in the bumper assembly against its bias and distortion of the resilient body in the bumper assembly as means for absorbing the energy of impact of the drive piston and cushioning the termination of the power stroke.

Many other objects and advantages of the present invention will become apparent from considering the following detailed description in conjunction with the drawings in which:

FIG. 1 is a fragmentary sectional view of a fastener driving tool including an improved bumper assembly shown in a normal position;

FIG. 2 is a sectional view similar to FIG. 1 illustrating the bumper assembly in a partially displaced position; and

FIG. 3 is a sectional view similar to FIGS. 1 and 2 showing the bumper assembly at the termination of a power stroke of the tool.

Referring now more specifically to the drawings, there is illustrated a fastener driving tool which is indicated generally as 10 and which embodies the present invention. The tool 10 includes a housing 12 defining a cylinder 14 in which is slidably mounted a piston 16 to the lower end of which a fastener driving element or blade 18 is connected. The lower end of the blade is slidably received within the drive track formed in a nosepiece assembly 20 to which staples are supplied by a suitable magazine assembly indicated generally as 22. The piston 16 and the connected driver blade 18 are driven downwardly to engage and drive a fastener supplied by the magazine 22 in response to the admission of compressed air or a pressurized fluid to the upper end of the cylinder 14. In accordance with the present invention, a new and improved cushioned piston stop or bumper assembly 24 is disposed at the lower end of the cylinder 14 for engaging and arresting downward movement of the piston 16 at the termination of its power stroke.

The construction and operation of the pneumatically operated tool 10 can be of any suitable type, such as one of those shown and described in detail in United States Patent Nos. 2,979,725; 3,040,709; 3,043,272; and 3,099,012. In these constructions, the structure forming the cylinder 14 can either be formed rigid with the housing 12 or mounted for sliding movement relative to the housing. The piston 16 can be of a single or different

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diameter structure and can be returned by pneumatic or resilient means. To simplify the illustration, the structure forming the cylinder 14 is shown integral with the housing 12 and is of a single diameter to receive the piston 16. Similarly, the magazine assembly 22 can be of any suitable construction for feeding successive staples or nails into the drive track defined by the nosepiece structure 20.

The bumper or piston stop assembly 24 includes a piston member or means 26 having a larger diameter upper portion 26a and a smaller diameter lower portion 26b. The piston means 26 is slidably mounted within a cylinder means 28 which is formed concentric with the cylinder 14 at the lower end thereof and which includes a greater diameter upper portion 28a and a smaller diameter lower portion 28b. The upper portion 26a of the piston is slidably mounted in the cylinder portion 28a, and the smaller diameter portion 26b of the piston means 26 is slidably mounted in the smaller diameter lower portion 28b. Sliding contact between the piston and cylinder portions 26a and 28a is sealed by an O-ring 30 carried on the piston portion 26a, and sliding contact between the piston and cylinder portions 26b and 28b is sealed by an O-ring 32 carried on the smaller diameter portion 26a of the piston 26. An annular or resilient bumper element 34 formed of synthetic or natural rubber or other resilient material is disposed in a cylindrical center opening 36 in the piston means 26 and includes an upper edge or surface that normally projects upwardly above the upper surface of the piston means 26. An axially disposed center opening 38 in the resilient bumper 34 and an opening 40 in the lower wall of the piston 26 permit the driver element 18 to pass through the bumper assembly 24 into the drive track formed by the nosepiece structure 20.

The bumper assembly 24 is normally biased to an upper position in which the upper surface of the piston 26 engages an annular stop ring 42 carried by a groove in the wall of the cylinder 14. The assembly 24 is biased by pressurized fluid or compressed air supplied to the area bounded by the O-rings 30 and 32 through a passageway 44. The passageway 44 communicates with a source of pressurized fluid or compressed air on the housing 12 of the tool 10, such as a reservoir indicated generally as 46. The pressurized fluid admitted to the portion of the cylinder 28 bounded by the O-rings 30 and 32 acts on the downwardly facing surfaces of the larger diameter portion 26a of the piston 26 to provide an upwardly directed component of force that normally seats the upper surface of the piston 26 in engagement with the stop means 42. When the bumper assembly 24 is moved downwardly against the bias, engagement of the lower wall of the smaller diameter portion 26b of the piston means 26 is cushioned by a resilient stop provided by an O-ring 48 disposed in the lower end of the smaller diameter cylinder 28b.

The "stiffness" of the bumper assembly or its resistance to movement on impact with the drive piston 16 is determined by the net upwardly directed force acting on the piston means 26. This force can be controlled by selecting the difference between the diameters of the piston portions 26a and 26b so as to control the effective downwardly facing area exposed to the pressurized fluid. This force can also be controlled by varying the pressure of the fluid supplied to the cylinder 28.

In the normal condition of the tool 10, the drive piston 16 occupies its normal position spaced above the lower end of the cylinder 14, and the compressed air or pressurized fluid supplied from the reservoir 46 through the passageway 44 continuously biases the upper surface of the piston 26 against the stop 42 so that the piston bumper or cushioned stop assembly 24 occupies the position illustrated in FIG. 1 of the drawings. When the tool 10 is operated, pressurized fluid is supplied to the cylinder 14 above the piston 16 to drive the piston 16 downwardly. During this downward movement, the lower end of the

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driver blade 18 engages and drives a fastener supplied to the drive track in the nosepiece assembly 20 by the magazine assembly 22.

The bumper assembly 24 cushions the termination of this power stroke. More specifically, at the end of the power stroke, a reduced diameter portion or boss 16a on the piston 16 moves into engagement with the upper surface of the resilient element 34 so that continuing downward movement of the piston 16 is effective to move the piston 26 downwardly against the bias afforded by the pressurized fluid or compressed air from the position shown in FIG. 1 to the position shown in FIG. 2. This movement of the piston 26 within the cylinder 28 absorbs a substantial portion of the kinetic energy of the piston 16 and the connected driver blade 18. The downward movement of the piston 26 and the components carried thereon is terminated by engagement of the lower wall of the piston 26 with the resilient stop member 48.

Any continuing downward movement of the piston 16 serves to dissipate kinetic energy by deforming resilient bodies. As illustrated in FIG. 3 of the drawings, the resilient stop member provided by the O-ring 48 is distorted by the downward movement of the piston 26 and serves to absorb energy. However, the largest quantity of energy is absorbed by distorting or deflecting the resilient element 34 which is engaged by the depending portion 16a on the piston 16. Thus, the downward movement of the piston 16 and the connected driver blade 18 is terminated by the assembly 24 which absorbs a portion of the energy in moving the piston means 26 against the resilient bias afforded by the pressurized fluid and the remaining energy by distorting the resilient elements 34 and 48. The bumper assembly 24 provides means for cushioning the termination of power strokes in larger tools possessing greater kinetic energy, which means is not dependent on the fatigue characteristics of resilient material and is capable of providing satisfactory operation over an extended period of time.

When the tool 10 is released by connecting the interior of the cylinder 14 disposed above the piston 16 to the atmosphere, the piston 16 and the driver blade 18 are restored to their normal positions by any suitable piston return means. The compressed air supplied to the cylinder 28 through the passageway 44 acts on the downwardly facing surface of the larger diameter portion 26a of the piston 26 to return the bumper assembly 24 from the deflected or operated positions shown in FIGS. 2 and 3 to the normal position shown in FIG. 1.

Although the present invention has been described with reference to a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be provided by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A fastener driving tool comprising a housing having a cylinder, fastener driving means including a piston movably mounted within the cylinder, said piston being normally disposed at one end of the cylinder and being movable during a power stroke to the opposite end of the cylinder, cylinder means concentric with the cylinder and disposed at said opposite end of the cylinder, said cylinder means having portions of different diameter, piston means of corresponding different diameters slidably mounted in the cylinder means, means for supplying a pressurized fluid to the cylinder means between said portions of different diameter to bias the piston means toward the drive piston, and means for limiting movement of the piston means toward the drive piston so that the piston means is spaced from but disposed in the path of movement of the drive piston during a power stroke, said piston means being engaged and moved against the bias of the pressurized fluid by the drive piston to cushion the termination of the power stroke of the drive piston.

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2. The apparatus set forth in claim 1 including a body of resilient material carried on the piston means and adapted to engage the drive piston.

3. The apparatus set forth in claim 1 in which a fastener driving means actuated by the drive piston extends through the opposite end of the cylinder, and in which the piston means includes an opening through which the driving means extends.

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